



# To Study the Effect of Human Hair Mixed with Tyre Waste (Rubber) On Properties of Concrete

**SANDEEP YERABATI**

Student-passed out, Department of Civil  
Engineering, M.V.S.R. Engineering College,  
Osmania University, Hyderabad, Telangana, India

**N VASUDEVA KAUSHIK**

Student-passed out, Department of Civil  
Engineering, M.V.S.R. Engineering College,  
Osmania University, Hyderabad, Telangana, India

**Mrs. SHWETA KAUSHIK**

Assistant Professor, Department of Civil Engineering, M.V.S.R. Engineering College, Osmania University,  
Hyderabad, Telangana, India

**Abstract:** Hair reinforced concrete mixed with rubber offers a practical and economical method for overcoming micro-cracks and similar type of deficiencies. Fibres are usually used in concrete to control plastic shrinkage and dry shrinkage cracking and also to lower the permeability of concrete. This is an attempt to find the possibilities of using hair as fibre reinforcement in concrete, thereby forming an alternative way for the safe management of hair waste. Present studies has been undertaken to study the effect of human hair mixed compressive, crushing, flexural strength and cracking control to economise concrete and to reduce environmental problem. In the experiment we have added human hair fibres to the concrete mixed with Rubber and studied the strength properties of concrete with the variation in Rubber content. i.e., to study the properties of concrete (M40 Grade ) for fibre content of 1.5% and rubber content of 3%, 6%, 9%, 12% at 7 days, 14 days, 28days. For each combination of proportions of concrete one beam and three cubes are tested for their mechanical properties. By testing of cubes and beams we found that there is an increment in the various properties and strength of concrete by the addition of human hair as fibre reinforcement and partial replacement of rubber as coarse aggregate. For the experiment, we have casted 45 cubes, 15 beams and 15 cylinders respectively.

**Key Words:** Hair Reinforcement Concrete; Tyre Waste; Compressive; Crushing; Flexural Strength;

## I. INTRODUCTION

To minimise the corrosive effect of salt on steel reinforced concrete, a modification in the form of Hair Fibre Reinforced Concrete (HFRC), in which the structure is adhesively bonded with hair fibre composites is proposed. HFRC is advantageous in wide-ranging aspects over the brittle-natured non reinforced cement based matrix. This structure is best known to enhance the tensile strength and augment the cracking and deformation characteristics. The resultant concrete is homogeneous and isotropic. The randomly oriented fibres make it more ductile. Bleeding of concrete is checked by the fine fibres reducing the permeability thereby resulting in improved surface characteristics and a hardened surface. Some fibres even make the concrete shatter-resistant. The HFRC has to be made economically viable to enable it to compete with the existing concrete system.

A small quantity of tiny waste tyre pieces can also do wonders when they partially replace coarse or fine aggregate of concrete. The benefits include making the concrete tough, highly ductile as well as incorporating better shock-absorption and insulation properties.

## II. LITERATURE REVIEW

During this study, following papers in the form of Literature have been referred:

T.Naveen kumar<sup>1</sup> , M.Vinod Baba<sup>1</sup> , Komershetty Goutami<sup>1</sup> , Jinna Aditya<sup>1</sup>, Kuppala Kavya<sup>1</sup> , V.Raja Mahendar<sup>1</sup> , Dr. R.C.Reddy<sup>2</sup> and Shweta kaushik<sup>3</sup> published a paper on” an experimental study on mechanical properties of human hair fibre reinforced concrete (M-40 grade)”.

It was found from the papeo that M-40 grade concrete with 1.5% human hair fibre shown an increase in compressive strength of 7.22%, 7.21% and 8.18% at curing periods of 7 days, 14 days and 28 days respectively when compared with the plain cement concrete

Renju.R.Pillai&AyothiramanRamanathan - IIT Delhi [1] presented a journal “An Innovative Technique of Improving the Soil Using Human Hair Fibre” in 2012. It shows a laboratory scale study on the influences of soil properties with the inclusion of human hair as fibre. The main objective this study is to investigate the suitability of solid waste materials such as human hair fibres in the process of soil stabilization as a reinforcement which can replace conventional commercial fibre materials. The influence of reinforcement parameters i.e. fibre content on Kaolinite clay was observed through a series of laboratory tests such as consistency limit tests, compaction tests and unconfined compression tests. The test results show that the MDD initially reduces lightly, OMC increases marginally due to

moisture absorption of hair fibres and Slight increase in the liquid limit and slight reduction in plastic limit thereby increasing the plasticity of soil revealing that the inclusion of randomly distributed human hair fibre in soil significantly improves the engineering properties of soil. Also with addition of 2.0% fibres by weight, the unconfined compressive strength increased up to 2 times that of unreinforced soil. From the stress-strain curve it is clear that the ductility of composite is also improved. This clearly indicates that the human hair fibre could be used in the improvement of cohesive soils.

**Darsh Belani, Prof. Jayeshkumar Pitroda & Dr F S Umrigar - B.V.M Engineering College, Gujarat [2]** wrote a journal on “Use of Human Hair as Natural Fibre for Fly Ash Bricks” in August 2013. It states that the human hair waste can be recycled, such as by incorporating in brick-making. This way the fly ash bricks are made a ‘greener’ building material and the discarded natural wastes can be re-utilized, avoiding otherwise wasteful landfill and harmful open incineration. The aim of this study is to investigate the strength and water absorption of fibre fly ash bricks made of human hair fibre and fly ash. This study examined the various properties of fly ash bricks made by adding human hair to a fly ash brick mix. The fibres were replaced within the range of 0.1-0.7% by weight of fly ash. In this study, 8 different mixes of fibre fly ash bricks are tested for parameters like: crushing strength, weight, water absorption and cost. It was observed that there is increment in properties of fly ash bricks according to the percentages of human hair fibre by weight and was found to be economical. It also faced the problem of uniform distribution of hair in the fly ash mix. So to overcome this problem they have adopted the manual method of distribution of hair in the fly ash mix.

**Dr.SinanAbdulkhaleqYaseen - University of Salahaddin[3]** published a journal “An Experimental Investigation into the Mechanical Properties of New Natural Fibre Reinforced Mortar” in 2013. In this paper, human hair fibre (HHF) is studied as a reinforced material in cementitious material. A total of 86 concrete specimens (Cubes, cylinders, prisms and plates) were tested to study the effect of including human hair fibres HHF reinforcement on the mechanical properties of flowable mortar fibre reinforced concrete. Fibres of different lengths and equivalent diameters were used with an aspect ratio ranged from 500 to 700, fibre content ranges from zero to 1 percent by volume. The influence of fibre content on the compressive strength, splitting tensile strength, flexural strength and load deflection is presented for two w/c ratios (0.6 and 0.7). An improvement in the energy absorption capacity due

to the fibre addition was observed, and the optimum fibre volume fracture was seen to be 0.8%. Energy absorption capacity and ductility factor were improved considerably when fibre content increased, which makes using the HHF suitable for seismic force resistant structures. It was observed that when fibres which are too long tend to "ball" in the mix and created workability problem. Therefore, to get more homogeneous dispersion and avoiding balling of hair fibre, more studies are required to find randomly mixing methods without balling effect for gaining better result in another mortar or concrete testing researches. They mentioned that the experimental findings in their tested samples would encourage future researches in this direction for long term performance to extending this cheap type of fibres for use in structural applications especially for low strength cementitious materials.

**Ilker Bekir Topcu et al (1995)** proposed the concrete was modified by mixing with crumb rubber in coarse aggregate in the ratio of 15%, 30% and 45%. In this study the changes of the properties of rubberized concrete were investigated according to the terms of both size and amount of rubber chips added. In this the physical and mechanical properties were determined according to that the stress strain diagram were developed from that the toughness value and the plastic and elastic energy capacities were determined.

**Fattuhi et al (1996)** proposed that, the cement paste, mortar, and concrete mixes were prepared using various proportions of either rubber crumb or low-grade rubber obtained from shredding scrap tyres. Results showed that density and compressive strength of various mixes were reduced by the addition of rubber. Density varied between about 1300 and 2300 kg/m<sup>3</sup>. Compressive strength reduced by 70% when the proportion of rubber to total solid content by mass of concrete reached about 13%.

**Piti Sukontasukkul et al (2004)** proposed the paper on crumb rubber concrete. In their study they decided to replace the coarse and fine aggregate in concrete for moulding pedestrian blocks. They believe that the concrete acting as a binder mixed with crumb rubber can make the concrete blocks more flexible and it provide softness to the surface. In this study they saw that the pedestrian blocks with crumb rubber performed quite well in skid and abrasion resistance. In this study the process of making the concrete is economical due to the simplicity of the manufacturing process.

### III. EXPERIMENTAL PROGRAMME

#### 3.1 Materials Used

**Cement :** It is mixture of calcareous, siliceous, aluminous substances and crushing the clinkers of a

fine powder. The ordinary Portland cement of 43 Grade is used. The specific gravity of cement is 3.15. For ordinary Portland cement, the initial setting time is 45 minutes and the final setting time is 600 minutes. The oxide contents are as follows : 60-67% CaO, 17-25% SiO<sub>2</sub>, 3-8% Al<sub>2</sub>O<sub>3</sub>, 0.5-0.6% Fe<sub>2</sub>O<sub>3</sub> and 0.1-0.4% MgO.

**Fine Aggregate:** The sand used for the experimental programme was locally procured and confirmed to grading zone II. The sand was sieved first through 4.75mm sieve to remove any particles greater than 4.75mm and was then washed to remove dust. The properties of fine aggregates are as follows : Specific gravity – 2.65 and Fineness Modulus – 3.35.

**Coarse Aggregate:** The material whose particles are of size as are retained on I.S. Sieve No. 480 (4.75 mm) is termed as Coarse Aggregate. The size of coarse aggregate depends upon the nature of work. The coarse aggregate used in this experimental investigation are of 20mm (60%), 16mm (20%) and 12mm (20%) sizes, crushed angular in shape. The aggregates are made free from dust before being used in the concrete. Its specific gravity is 2.74.

**Water:** Water used in the experimental work is conformed to IS: 456-2000 for mixing as well as curing of Concrete specimens.

#### **Tyre Rubber:**

As it is a waste material and causing a environmental pollution we are using it as partial replacement of coarse aggregate. It is easily available locally at cheaper cost. We are using the size of rubber range varies from 15 to 20 mm. Shape of rubber is triangular.

#### **Human Hair:**

#### **Aim of the experiment:**

The aim of our project is to use the human hair fibres as fibre reinforcement in concrete mixed with Rubber

#### **Objective:**

To study the strength properties of concrete with the variation in Rubber content. i.e., to study the properties of concrete (M40 Grade ) for fibre content of 1.5% and rubber content of 3%, 6%, 9%, 12% at 7 days, 14 days, 28days. The strength properties being studied in our thesis are as follows:

1. Compressive strength
2. Split tensile strength
3. Flexural strength

## **IV. EXPERIMENTAL PROGRAM**

To study the interaction of human hair fibres with rubberised concrete experiments were conducted on 45cubes, 15beams and 15 cylinders.

Each group consists of 9 cubes of size 150mm x150mm x 150mm, 3 beams of size 150mm x150mmx 700mm and 3 cylinders of size 150mm diameter and 300mm length respectively

1. The first group is the Plain concrete with 0% fibre (PCC) and 0% Rubber by weight of coarse aggregate.
2. The second group consisted of 1.5% of human hair fibre by weight of cement and 3% Rubber by weight of coarse aggregate.
3. The third group consisted of 1.5% of human hair fibre by weight of cement and 6% Rubber by weight of coarse aggregate.
4. The fourth group consisted of 1.5% of human hair fibre by weight of cement and 9% Rubber by weight of coarse aggregate.
5. The fifth group consisted of 1.5% of human hair fibre by weight of cement and 12% Rubber by weight of coarse aggregate.

- Cement is added to the sand and mixed thoroughly by hand to get a uniform colour.
- The coarse aggregate and rubber is spread on the ground and hair fibres of length 60mm is mixed with cement-sand mixture to get a uniform distribution of the mixture.
- For casting the cubes, beam specimens, standard cast iron metal moulds of size 150×150×150 cubes, 150×150×700mm beam moulds are used.
- After mineral oil is applied on all sides of the mould, thoroughly mixed concrete is filled into the mould in three layers of equal heights followed by tamping using a rod of 16mm diameter.
- Then the mould is placed on the table vibrator and the excess concrete is removed from the top layer.
- The specimens are stored in the laboratory for 24hours at room temperature.
- After removing from the moulds, the specimens are submerged in fresh and clean water and cured for 28days.

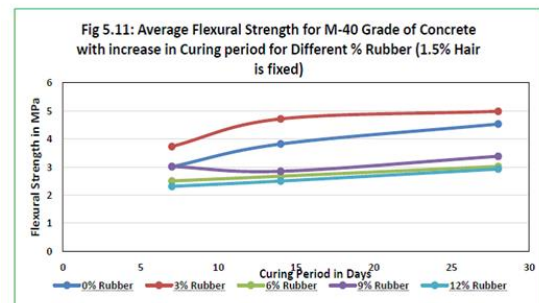
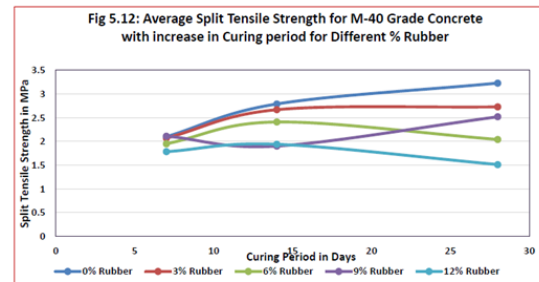
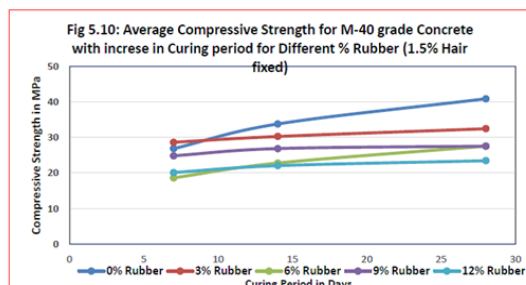
## DETAILS OF NUMBER OF SPECIMENS PREPARED:

M-40 Grade	Percentage of Rubber added by weight of coarse aggregate with 1.5% hair fixed						
Name of Specimen	0%	3%	6%	9%	12%		Total
Cubes	9	9	9	9	9		45
Beams	3	3	3	3	3		15
Cylinders	3	3	3	3	3		15
Total Number of Specimens							75
M-40 Grade of Concrete	For Each percentage of Human hair						
	CURING PERIOD						
Name of Specimen	7 Days Strength		14 Days Strength		28 Days Strength		
Cubes	3		3		3		
Beams	1		1		1		
Cylinders	1		1		1		
Group of total Specimens for each percentage							15

S.No.	% Rubber	COMPRESSIVE STRENGTH in MPa		
		7 Day Strength	14 Day Strength	28 Day Strength
1	0	26.84	33.74	40.80
2	3	28.60	30.23	32.42
3	6	18.61	22.75	27.51
4	9	24.80	26.82	27.51
5	12	20.10	22.03	23.43

S.No.	% Rubber	SPLIT TENSILE STRENGTH in MPa		
		7 Day Strength	14 Day Strength	28 Day Strength
1	0	2.10	2.79	3.23
2	3	2.07	2.67	2.73
3	6	1.95	2.41	2.04
4	9	2.11	1.90	2.52
5	12	1.783	1.94	1.51

S.No.	% Rubber	FLEXURAL STRENGTH in MPa		
		7 Day Strength	14 Day Strength	28 Day Strength
1	0	3.01	3.82	4.53
2	3	3.73	4.71	4.98
3	6	2.50	2.67	3.02
4	9	3.02	2.85	3.38
5	12	2.31	2.50	2.93



## V. CONCLUSIONS

The following are conclusions that are drawn out from this experimental study. It is observed that there is increments as well as decrements in properties of M-40 grade of concrete according to the percentages of Rubber by weight of coarse aggregate (1.5% hair fixed).

From this experimental study, it is found that the optimum content of Rubber to be added to M-40 grade of concrete is 3%.

When M-40 concrete mixed with 3% Rubber (1.5% hair is fixed) is compared with the plain cement concrete, it is found that

Curing Period in Days	Increment (+) and Decrement (-) in Mechanical Properties		
	Compressive Strength	Flexural Strength	Split Tensile Strength
7 Days	6.56% (+)	23.92% (+)	1.43% (-)
14 Days	10.40% (-)	23.30% (+)	4.30% (-)
28 Days	20.54% (-)	9.934% (+)	15.48% (-)

### Benefits of adding human hairs to concrete:

- Increase in tensile strength and compressive strength
- Better binding properties
- Micro-cracking control
- Improved spalling resistance
- Substantial reduction in crack width
- Ductility is imparted which aids in safe application as the beam tends to bend well in advance therefore avoiding failure



### Replacing partially, the coarse or fine aggregate of current with an amount of small waste tyre cubes i.e., Rubber Modified Concrete (RMC):

- Merits:
  - Affordable and cost-effective
  - Can withstand impact, high pressure and temperatures better
  - Good resistance to water because it absorbs less
  - Resistance to acid
  - Augmented thermal and sound insulation
  - Low unit weight
  - Resistance to abrasion
  - Shock and vibration absorption
  - Ductility
  - Toughness
- De-merits
  - Rubber is properly mixed with the concrete in both dry and wet form but rubber gets separated and emerges at the top of the mould during compacting and vibrating.
  - Since rubber absorbs less water, bleeding occurs.
  - The concrete matrix gets disturbed when the content of rubber is more.
- Applications
  - Concrete structures where risk of earthquakes is high
  - Where severe dynamic actions are observed, like Railway sleepers.

### Future scope:

Further research can be conducted in this type with respect to the following areas-

- Rubber's distribution matrix
- Working of silica fume and superplasticizers to increase compressive strength

### VI. REFERENCES

- [1]. Renju.R.Pillai&AyothiramanRamanathan, "An Innovative Technique of Improving the Soil Using Human Hair Fibre" ( 2012)
- [2]. DarshBelani, Prof.JayeshkumarPitroda& Dr F S Umrigar, "Use of Human Hair as Natural Fibre for Fly Ash Bricks" (August 2013)
- [3]. Dr.SinanAbdulkhaleqYaseen , "An Experimental Investigation into the Mechanical Properties of New Natural Fibre Reinforced Mortar" (2013)
- [4]. Tomas U. Ganiron Jr. Australian Institute of Geoscientists, "Effects of Human Hair Additives in Compressive Strength of Asphalt Cement Mixture" (2014)
- [5]. A.S.Balaji1 and D.Mohan Kumar2, "Laboratory Investigation Of Partial Replacement Of Coarse Aggregate By Plastic Chips And Cement By Human Hair" (2014)
- [6]. Avinashkumar, B.Tech Final year student , "A study on mechanical properties of Hair fibre reinforced Epoxy composites" ( May'2014 )
- [7]. P. Ramadoss\* and K. Nagamani , "Tensile Strength And Durability characteristics Of High-Performance Fiber reinforced Concrete
- [8]. Waweru Nancy Mugure, " investigation of the performance of natural fibres as a micro reinforcement in concrete", (2009)
- [9]. D. Senthilnathan, A GnanavelBabu , G. B. Bhaskar, KGS. Gopinath, "Characterization of Glass Fibre – Coconut Coir– Human Hair Hybrid Composites", (2014)
- [10]. Sameer Ahmad, "Preparation of Eco-Friendly Natural Hair Fiber Reinforced Polymeric Composite (FRPC) Material by Using Of Polypropylene and Fly Ash: A Review, (2014)
- [11]. Eldin, N.N., Senouci, a. b., Rubber-tire particles as concrete aggregate, ASCE journal of materials in civil engineering, vol. 4, pp. 478-496, 1993
- [12]. F. Pacheco Torgal, A. Shasavandi, S. Jalali, "Tyre rubber based concrete: A Review" WASTES: Solutions, Treatments and Opportunities 1St International Conference September 12th – 14th 2011.
- [13]. Gregory GRRICK, 2004. **Analysis of waste tire modified concrete.** In: 2004 ME Graduate Student Conference, Louisiana State University.
- [14]. G. SenthilKumaran, NurdinMushule and M.Lakshmipathy ,3School of Civil Engineering, SRM University, Chennai, Tamilnadu, India, "A Review on Construction Technologies that Enables Environmental Protection: Rubberized Concrete." American J. of Engineering and Applied Sciences 1 (1): 40-44, 2008.
- [15]. 2008.
- [16]. Jo, B.W. et al, Characteristics of cement mortar withnano-SiO<sub>2</sub> particles, Construction and Building Materials, Article

- in press, doi:  
9.1016/j.conbuildmat.2005.12.020,2006.
- [17]. K.C. Panda, P.S. Parhi, T.Jena, **“Scrap-Tyre-Rubber replacement for aggregate in cement concrete: Experimental Study”** International journal of Earth Sciences and Engineering, P.P.1692-170 December 2012.
  - [18]. Kotiesh K.M., MesfinGetahunBelachew, **“Study on Waste Tyre Rubber as Concrete Aggregate”** International Journal of Scientific Engineering and Technology, Volume No.3 Issue No.4, pp: 433-436, 1April 2014.
  - [19]. MalekK.Batayneh, Iqbal Marie, Ibrahim Asi, **“Promoting the use of Crumb Rubber Concrete in developing countries”**, Civil Engineering Department, Faculty of Engineering, The Hashemite University, Zarka 13115, Jordan, December 2007.
  - [20]. M. Movroulidou, J. Figueiredo, **“Discarded Tyre Rubber as Concrete Aggregate”**, Global NEST Journal, Vol 12, No 4, pp 359-367, 2010.
  - [21]. Mohammad Reza sohrabi, Mohammad karbalaie, **“An experimental study on Compressive Strength of concrete containing Crumb Rubber.”**, International Journal of Civil & Environmental Engineering IJCEE-IJENS Vol: 11 No: 03, June 2011.